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OWNING THE WEATHER IN THE MARITIME ENVIRONMENT

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A paper submitted to the faculty of the Naval War College in partial satisfaction of the requirements of the Department of Joint Military Operations.

The contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.

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17 May, 2005

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Abstract

There is a long history of weather impacting military operations. Today's U.S. Joint Forces must incorporate a thorough understanding of the battlespace environment into plans and execution in order to optimize the current generation of high-tech weapons and sensors. The Air Force, Army and Marine Corps place a high value on effectively working knowledge of the environment into all aspects of military operations. For largely cultural reasons the Navy continues to view weather more as a potential hazard, or limit to operations rather than as actionable force-multiplying "intelligence." This is a potential problem for the Joint Force Maritime Component Commander (JFMCC) working with limited resources against an enemy seeking to exploit asymmetric advantages (e.g., weather, terrain). A strategy for better incorporating weather into Maritime Operations and Plans through both organizational changes within the JFMCC, and adopting a philosophy of accountability regarding the integration of plans and forecasts is suggested.

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Know the terrain and know the weather and your victory will be complete.
Sun Tzu, The Art of War

Introduction

No military commander would contend that weather is an unimportant consideration in operational planning and execution. But if we ask these same commanders to define what "knowledge of the weather" means, there would hardly be a consensus of opinion. Some would consider weather a knowable quantity that—like intelligence—is to be fully considered in planning and leveraged for military advantage, while others might simply view it as a hindrance to operations that must be taken on as an acceptable risk. Put another way, military planners have the option of either fighting *with* the weather, or *against* it. History yields numerous examples of each these approaches.

This same issue remains relevant in the modern world of U.S. joint warfare. While the Joint Force Air Component Commander (JFACC) has come to rely more heavily on both deliberate and near-real-time weather injects, particularly in planning and executing the Master Air Attack Plan (MAAP) and Air Tasking Order (ATO), and the Marine Corps considers weather a critical element of detailed planning, the Navy (and by rough association the Joint Force Maritime Component Commander (JFMCC)) tends to retain a more skeptical view of the "knowability" of weather. As a result, naval weather forecasting has drifted toward irrelevance, with the Commander Naval Meteorology and Oceanography (CNMOC) now focusing primarily on oceanographic initiatives.[1]

This need not be the end of the story. Advances in both long-and short range computer weather modeling, particularly regarding battlespace impacts, combined with an emerging generation of skilled, operationally-savvy forecasters offers the JFMCC an

opportunity to apply a “graduate level” understanding of weather impacts to the expanding array of Joint Maritime Operations. This is not likely to happen on its own, as there are deep cultural and organizational underpinnings that have led to the marginalization of naval weather support. When armed with an understanding of these root causes, the Maritime Component Commander can take immediate, positive actions that will ensure weather information is brought to bear as truly force multiplying “intelligence” along the lines of what Sun Tzu might have envisioned.

Background: Weather and Military History

Weather—the other enemy

While there may be debate as to how best to account for weather in military operations, the fact that weather can affect the outcome is not in dispute. It was storms and the "Protestant Wind," more than the British that defeated the Spanish Armada off the coast of Scotland in 1588.[2] Charles Pichegru was similarly aided by weather in 1795 as he captured the Dutch Navy that had been frozen in place by ice. “General Winter” proved to be Russia’s most important strategist in repelling both Napoleon’s *Grand Armée* in 1812 and Nazi Germany in 1941.[3]

The most dramatic case of the military fighting the weather, at least in recent history, is Admiral Halsey’s experience with typhoons in the Pacific. His decision to continue fueling efforts in the Philippine Sea in December of 1944 in the face of obviously deteriorating weather resulted in a large-scale disaster that Admiral Nimitz would later refer to as the “greatest uncompensated loss that the Navy had taken since the Battle of Savo Island.” [4]

Weather as a weapon

There are also numerous occasions when planners and tacticians have used knowledge of the weather to their advantage. The planned utilization of weather "windows"—where the usual terms "good" or "bad" relate only to the desired outcome (e.g., a Marine commander may prefer a rainy and windy night with poor visibility for the clandestine insertion of special reconnaissance teams)—can deliver an advantage otherwise unachievable by firepower alone. Japanese air tactics in WWII, for example, included a tendency to attack during poor weather,[5] and the Germans used the cover of fog and heavy snow to infiltrate American positions during the Battle of the Bulge in late 1944. Only clearing skies and the accompanying Allied air support halted the offensive.

No event put the value of an accurate weather forecast on display more than the Allied invasion of Normandy. By executing the mission within a narrow, expertly forecast window of opportunity, Eisenhower was able to both get troops ashore in a period of generally unfavorable conditions, and employ the vital element of surprise, as the Germans were not expecting such a landing to take place given the overall state of the environment. In the words of General Omar Bradley, "In this capricious turn of the weather, we had found a Trojan horse."[6]

While many more examples could be cited, my purpose in this brief review is simply to establish that weather can easily impact military operations on a similar order of magnitude as detailed intelligence, superior maneuver, or overwhelming force. Whether such impacts are used to an advantage or simply lead to unanticipated—even catastrophic—complications depends largely upon a commander's philosophical view of weather as it relates to the application of operational art.

Weather and Modern Joint Warfare: *A Cultural Analysis*

Though understanding the weather has long been important to U.S. military operations, prior to WWII the support organization was largely ad-hoc. The 1942 establishment of the Joint Meteorological Committee and concurrent declaration of the Weather Bureau as a *war agency* gave rise to the cooperative civil-military weather services that would come to be known as the Air Force Air Weather Service (AWS), the Navy Meteorological and Oceanographic Command, and the National Oceanographic and Atmospheric Administration.[7] Aside from the obvious service responsibilities (note that the AWS provides direct support to both the Army and the Air Force), arguably the most important role the military weather services play today is in the support of major Joint Force Commanders (JFC).

At this level, the Meteorological and Oceanographic (METOC) support structure is designed to be consistent among services. In order to develop an "assessment of the physical environment" as part of the overall effort to "prepare the operational area" prior to combat[8], the JFC will typically assign a Joint Force METOC Officer within the J-2 or J-3 organization, who will then stand-up a Joint METOC Forecast Unit (JMFU) composed of service-neutral METOC assets (normally either a Naval Meteorological and Oceanographic Center, or Air Force Operational Weather Squadron) within the given Area of Responsibility. The main product of the JMFU is the Joint Operating Area Forecast, which serves as the basis for the incorporation of METOC knowledge into battle plans constructed by the subordinate Components: the JFACC, the Joint Force Land Component Commander (JFLCC), the JFMCC and the Joint Force Special Operations Component Commander (JFSOCC).[9] Because my intent is to explore

differences in philosophy and process regarding how the Navy and Air Force treat and incorporate weather information, I will focus on support to the JFACC and the JFMCC.[10] The intent of this study is to offer all the Joint Force Component Commanders means of better incorporating knowledge of the weather into operational battle plans.

The Air Weather Service and the JFACC

For the United States, modern warfare has largely come to mean using overwhelming air superiority to deliver precision guided munitions, while minimizing collateral damage, and avoiding US losses. As such, the JFACC[11] is the most critical component commander in this type of warfare. The JFACC nearly single-handedly prosecuted Operations ALLIED FORCE, and ENDURING FREEDOM (OEF) in Afghanistan (in coordination with Special Operations Forces), and was essential to preparing the battle space for both DESERT STORM and IRAQI FREEDOM.[12]

It is precisely this "new" style of warfare that has only furthered the requirement to know the weather. The JFACC must not only consider atmospheric effects when "servicing" targets (i.e., getting the right weapon (e.g., GPS v. Laser guided) to the right place (primary or back-up targets) at the right time (launch, recovery, time on top, etc.,), but must also collect targeting intelligence, and conduct Battle Damage Assessment (BDA). As technology improves, these tasks become more dependent on identifying favorable weather windows.

Functionally, weather information is used by the JFACC through the director of the Joint Air Operations Center (JAOC) via the Combat Operations division. Joint Air doctrine also requires METOC knowledge be incorporated within the Strategy, Combat

Plans, and Intelligence, Surveillance and Reconnaissance (ISR) divisions to aid in both Joint Air Operations Planning (including MAAP development), and Intelligence Preparation of the Battlefield (IPB).[13] In addition, there is a real-time weather "cell" in the JAOC that acts as an advisory filter for virtually every scheduled mission. In this way, the JFACC ensures weather is at least *considered* across the entire spectrum of Joint Air planning and execution.

Still, DESERT STORM and ALLIED FORCE showed that weather information has not always been effectively employed by the JFACC. General McPeak's (then Air Force Chief of Staff) quip that DESERT STORM was plagued by "the worst weather in 14 years" simply highlights the fact that weather was not adequately considered in planning (re: the Air Force's over-reliance on new targeting pods (IR/Laser) and TV-guided missiles). Similarly, Lt. General Short's (CFACC, ALLIED FORCE) famous concession that the weather "just kicked our butts for the first 45 days"[14] points not to some sort of unexpected atmospheric anomaly, but rather to a lack of consideration of the road-blocks even *normal* spring weather in the Balkans would present to a high-tech, air-only campaign. Through the course of ALLIED FORCE, operable weather windows came to be viewed (finally—and appropriately) as "critical factors," and the Air Force cited its inability to "locate and attack moving armor and other ground forces in poor weather" as a primary lesson learned.[15]

More recent experience with ENDURING FREEDOM and IRAQI FREEDOM has resulted in better integration of METOC into Joint Air Operations. Most notable was the development of the Joint Direct Attack Munition (JDAM), which gave planners the option of using a GPS guided weapon during "bad" weather. But GPS guided munitions

can engage fixed targets only. Targets that are emergent or moving, (i.e., no GPS coordinates available), still require active guidance (e.g., Laser or electro-optics) to be acquired. As a result, air operational planners must now critically consider (not just *tolerate)* the battlespace environment by using weather widows most conducive to different kinds of weapon and target options available.

This type of execution of course depends on these windows being accurately and reliably forecast. In *The Masks of War*, Carl Builder refers to the Air Force's view of Air Power as "a strategy made possible and sustained by modern technology."[16] It is in this spirit that the Air Weather Service has "raised its game" by developing cutting-edge remote weather sensing and computer modeling applications so that JAOC forecast teams can deliver the detail demanded by the JFACC in MAAP and ATO development. Air Force Lt. Col (and OEF CAOC lead meteorologist) Fred Fahlbusch defines the objective as "to make sure people who are executing the ATO are not surprised, and are able to continue to execute despite what weather they encounter." General T. Michael Moseley (CFACC for Operation ENDURING FREEDOM) suggests that forecasters are hitting the mark. In an interview with The Weather Channel following Gulf War II, he said that "the forecasters are almost not in the business of forecasting as much as they are in the business of telling you what is going to happen."[17]

The Air Force is showing no sign of slowing its effort to make weather information more integral to battlefield operations. The current Air Force Weather (AFW) *Strategic Plan and Vision* highlights aggressive investments in collections (including mounting weather sensors on non-weather platforms), multi-scale modeling, and planning systems that embed human weather expertise from the start.[18] LTG Ronald

Keys, Deputy Chief of Staff, USAF Air and Space Operations lauds the plan not just for its embrace of technology, but because it "emphasizes the integration of information and people."[19] Moreover, there seems to be a culture of credibility and relevance built into Air Force Weather. The same cannot necessarily be said for Navy METOC.

Navy METOC and the JFMCC

In contrast to the emergent role of military air capability, there is little "new" about the concept of maritime power. Sea control has been a US military object since the days of Mahan, and naval power projection (including amphibious operations) matured during WWII. The JFMCC can be loosely viewed as the most recent iteration of maritime command and control—the JFCs *maritime warfighter*.[20]

Weather considerations are critical to exploiting the maritime battlespace, particularly in littoral waters. Planning and executing major amphibious landings are contingent on a thorough analysis of landing zone variables such as off-shore wave energy, surf amplitude and character, along-shore currents, wind velocity and direction, bottom topography, etc.,.[21] Similarly, factors such as precipitation, wind, waves, cloud cover, temperature, etc., impact the optimal employment of virtually every weapon, sensor, and aircraft system on navy ships today.[22] While the Air Force is demanding more and more detailed weather-impact knowledge to support the JFAAC, the opposite appears to be true with regard to the Navy and the JFMCC.

Compare the METOC organization within the components. At first glance, one might argue that knowledge of the environment is similarly incorporated within the structures of the JFACC and the JFMCC—both appear to be crafted in a way that makes

METOC support available to all relevant nodes. Recall that Joint Air doctrine *requires* that weather be addressed within the Strategy, Combat Plans, and ISR divisions when conducting Joint Air Operations Planning (including MAAP development), and IPB.[23] Contrast this with JFMCC doctrine that defines METOC as a "Maritime Support" function; a resource available to other JFMCC centers (Knowledge Management, Intel, Future Plans, Operations and Logistics) on an "as needed" basis.[24] So while doctrine suggests METOC *should* be considered by appropriate planners, there is no firm requirement to do so. CAPT (sel) Jim Pettigrew, former U.S. Seventh Fleet METOC Officer, notes that unlike Air and Land doctrine, "current [maritime] doctrine doesn't push us out into the cells the way we should be aligned."[25]

This is symptomatic of the key issue separating the Navy from the rest of the services with regard to weather consideration: *culture*. C. Raymond Calhoun's classic *Typhoon: The Other Enemy* illustrates the point by showing that with regard to weather-at-sea there is not only a strong—some would say *reckless*—"can do" tradition in the surface navy, but that ship COs almost by definition must be their own best forecaster. Calhoun notes that one of the tragedies of the December 18, 1944 typhoon was that by employing simple thumb rules the day before the storm hit, "even the most junior officers of the *Dewey* [Calhoun was the CO] had deduced there was a typhoon to the southeast of us and that the Third Fleet seemed to be directly in its path."[26] In contrast, CDR George F. Kosco, the MIT-trained meteorologist aboard the Third Fleet flag ship USS *New Jersey*, without the benefit of satellite imagery, and using a crude network of Western Pacific meteorological data advised Admiral Halsey that only a weak tropical disturbance existed and that it would most likely track away from the fleet. When the approach of the

typhoon became imminent on the morning of December 18th, Halsey, still focused on the fueling mission, was reluctant to take Kosco's desperate recommendation to move the fleet south. Three destroyers and over 800 men were lost at sea.[27]

In his final critique, Calhoun (whose vessel survived the storm) cites the general incompetence of the flag meteorologist as evidence that "forecasting the weather was a responsibility of the line," and that "it should not have been delegated to the staff aerologist."[28] The implication here is that knowledge of the weather is useful only insofar as it applies to hazardous weather avoidance (vice exploitable intelligence), and that such avoidance is really an "all hands responsibility" anyway. With some irony, the perceived value of specialized organic METOC support was diminished in the eyes of the fleet.

While it might be easy to dismiss Calhoun's remarks as just one man's opinion, there is evidence to suggest these views are widely held. Even to this day, the only piece of weather information certain to get the attention of a numbered fleet commander is an Optimum Track Ship Route (OTSR) divert of a vessel (normally associated with typhoon avoidance).[29] Additionally, operational level METOC briefs are too often conducted *after* all plans have been finalized and weathered out evolutions can easily be dismissed as uncontrollable "acts of God."[30]

Consider also how afloat navy METOC officers are employed. Naval Meteorology and Oceanography may represent the only restricted-line community that allows, even encourages, officers assigned to maritime staffs to hold *primary* duties unrelated to their specialties.[31] Compare this philosophy to the Naval Intelligence community, where officers routinely spend less than 20% of their time on non-

intelligence related matters (and the time-consuming qualification as a Surface Warfare Officer is viewed as a *negative* with regard to further promotion),[32] or to Air Force Senior Weather Officers, who are typically "100% engaged" in meteorological support when deployed to, e.g., a JFLCC staff.[33]

There are also significant differences in how the weather *communities* are viewed within the respective services. While Air Force Weather continues to develop its partnership with Air Force Intelligence in order to glean weather information from non-traditional platforms and collaboratively address the *Predictive Battlespace Awareness* problem (e.g., Time Sensitive Targeting)[34], Navy METOC has been far less successful in its effort to leverage operational platforms to collect relevant weather data. "The predominant [navy] warfighter perception is that buying a system that collects environmental data does not necessarily produce tangible improvements to combat capability," says CDR Paul Matthews, a former CNMOC requirements assistant.[35]

Weather Superiority in the Maritimes

Given the fleet's seeming "neither required nor desired" view of specialized meteorological support, it is easy to understand why CNMOC would instead focus on oceanography, where such cultural biases—particularly regarding the application of acoustics—are less evident.[36] While this may enhance the short-term relevance of Naval METOC, it does little to address the fact that the maritime wars of the future will be fought by the CFMCC (where Marines, raised in a culture where weather is treated as *actionable intelligence*, are just as likely to command as Naval officers)—and the requirement to exploit weather knowledge in the littorals will only increase.

In the age of the Global War on Terrorism, a CFMCC's employment priorities might notionally be described as (1) deter, disrupt and destroy terrorist organizations, (2) kill or capture terrorists, (3) deny terrorist use of the maritime environment, and (4) prevent terrorist acts at sea and ashore. Imagine for a moment the advantage a commander armed with detailed knowledge of the maritime environment would hold against an adversary counting on asymmetric advantages. By employing a sensing strategy, for instance, in tune with expected changes in environmental factors such as low-cloud cover and wind-driven dust, the commander can ensure he has the proper tools to see "through" the clouds at the precise moment he needs to (e.g., synthetic aperture radar), and is in a position to seize the initiative when weather windows open, thereby neutralizing the advantage a terrorist trying to use the weather for cover might exploit. Similarly, units (ships, patrol aircraft, helicopters, submarines, etc.,) tasked with interdicting suspect maritime traffic can be significantly more effective if employed in a course of action that accounts for—rather than is hindered by—expected shifts in wind, visibility and sea state. By being better able to *anticipate* changes, the CFMCC can overcome the "home court advantage" a terrorist group might try to exploit.

Technological advances

Any suggestion that such weather-leveraging strategies be employed would likely raise the concern that the state of the science does not offer the requisite reliability. Indeed, a plan based on a specific meteorological development that *does not verify* can be worse than a plan that does not consider weather at all. To be sure, there is much more to do from a scientific standpoint. Dr. Cliff Mass, University of Washington professor of

Atmospheric Sciences cites the prediction of middle eastern dust-storms, for example, as "...a major issue and one that our skill is improving in, but not perfect."[37] Still, recent advances in fine-scale modeling now allow forecasters to deliver crucial detail to current operations and near-term planners. These *mesoscale* models apply mainly terrain-induced dynamics to regional model output and can make good estimates of local cloud, precipitation, wind and wave characteristics over an area of interest, allowing a landing force commander, for instance, to optimize the movement of troops ashore in virtually any environment. Because these powerful models have very strict error thresholds (i.e., can be wildly inaccurate if improperly applied), they are most effectively employed by well trained forecast teams that thoroughly sense the operating environment.

Additionally, improvements in long-range computer weather modeling means that yesterday's climatology (what the Intelligence community would call *archival*), is being replaced by today's *forecast*. The accuracy of the National Center for Environmental Prediction (NCEP) Global Forecasting System (GFS) 5-day forecast has improved nearly 50% since 1984,[38] and GFS now regularly shows skill over climatology through 16 days. The result is that operational commanders can not only expect more detailed and accurate short-and mid-term weather predictions, but can incorporate actual forecast information into future operations (up to two weeks[39]) where in the past only broad climatological parameters could be reliably considered. In a breakthrough in long-range computer weather modeling, NCEP's Climate Forecast System was unveiled in August, 2004 and represents the first fully dynamic prediction model able to match the performance of statistically-based climate models of the past.[40] This suggests that environmental impacts at even long-range operational planning scales (6-9 months and greater) will soon be

talked about in terms of *weather* (or at least climate *anomalies*), instead of just historical averages. Think of the advantage a planner considering landing zones, operating areas, and force requirements would have if advised that, for instance, the normal trade wind regime for a given tropical landmass is likely to be disrupted over the anticipated operational period.

Sensing Strategies

Just as CDR Kosco (Halsey's meteorologist) was criticized for relying more on charts from Hawaii than weather observations from the fleet[41], the idea that modern computer models and remote sensing imagery alleviate the need for meteorologists to consider local observational data is misguided. Devising and executing a thorough battlespace sensing strategy may be the most important duty a Combatant or Functional Commander's staff meteorologist can undertake. Because detail-rich mesoscale models are inextricably tied to the regional scale models that drive them, every effort must be made to determine the validity of the large scale solution. The only way to do this is to collect real-time observational data from key representative points throughout the area of interest. Without such a sensing strategy, forecast teams can only "hope" the models are right. The operational commander who does *not* demand a thorough environmental sensing of the battlespace is immediately compromising the ability of his force to fully incorporate—and exploit—METOC knowledge in war planning and execution.

From Entertainment to Intelligence...A Strategy for Change

It has been said regarding military weather support that if you are not part of the decision loop, you are entertainment. I have argued that while the JFLCC and JFACC typically view specialized weather knowledge as actionable intelligence, the JFMCC tends to treat the same information as a sideshow, mostly because of service culture. Still, there are at least two actions the JFMCC can immediately take to shift METOC information out of the realm of entertainment and into the world of intelligence: (1) modify the weather "structure" within the CFMCC organization, and (2) hold planners and forecasters equally accountable for events degraded by weather conditions.

Structure

As previously noted, Joint Maritime doctrine places METOC into the "Maritime Support Center," along with personnel specialists, doctors, chaplains and lawyers. While I am in no way implying these other functions are not important, they are by definition "focused on serving information requirements generated by other centers."[42] The problem with making METOC an "as required" service is that it places the burden of knowing when to call on the operator. Enter the cultural problems discussed at length above. If the forecast is (or the *porthole shows*) "fair winds and following seas," most naval mariners would see no need to get some *weather guesser's* planning advice. But even in "good" weather, there are planning advantages to be had if the environment is understood in detail. Does sea state support small boat operations? If so which ones? Do (*will*) winds and seas allow for a rare surface re-supply of a submarine? Do offshore winds normally associated with good weather create potentially dangerous plunging surf

conditions? The truth is that weather—independent of any "good" or "bad" characterization—affects *every maritime evolution* to some degree. The planner who calls only "when there is a typhoon coming," is foregoing the opportunity to optimize the maritime force.

So how can METOC be better aligned within the Maritime warfighting structure? The solution could be as simple as *assigning* METOC specialists to the relevant cells (e.g., Current and Future OPS, Intelligence Plans and Assessment), much as INTEL has done.[43] The easiest way to accomplish this in fact might be to co-opt the structure INTEL has already established and assign the Senior METOC Officer to the J2 (Intelligence) department. While this is not typical within navy commands, METOC services *are* integrated into the Intelligence organizations of both the Army and Marine Corps. CAPT Sandy Neville (Senior Intelligence Officer, NWC) suggests that such a relationship would be "welcomed with open arms," as this type of collaboration would only serve to improve the Joint Intelligence Preparation of the Battlespace.[44] Developing and executing a battlespace sensing strategy, and anticipating optimal ISR windows of opportunity go directly to the IPB, and having METOC as part of the JIPB team would help to eliminate stovepipes within the joint planning organization. In addition, placing the METOC officer within the J2 organization (as opposed to a more traditional J3 assignment—often heavily loaded with non-METOC operations responsibilities) as a *directed consultant* to the Maritime Future Plans and Operations Centers would almost certainly result in METOC being better accounted for within the scope of maritime operations (including proposed JFACC-like documents such as the Master Maritime Attack Plan and Maritime Task Order).[45]

Accountability—the myth of the "Weather-Out"

Structural changes can only go so far within an organization predisposed to weather-neutral planning. There is a second, far more powerful initiative the JFMCC could take to move METOC more toward the realm of actionable intelligence: *demand accountability*. There is still a culture in the navy that evolutions either cancelled or degraded by weather impacts are unavoidable. But the truth is that many "weathered-out" events either result from bad forecasts, bad planning, or both. Imagine a strike sortie that is unable to reach its objective because the loaded fuel tanks were too small for the expected distance. The Commander, Air Group (CAG) will have *someone's* head for wasting valuable resources. However, if the same mission has to turn back because of a clouded-over target area, CAG is more likely to shrug off the mission as bad luck. A commander that views weathered-out missions as an acceptable risk is simply perpetuating the problem of planners failing to account for weather.

Adopting a "zero-tolerance" policy regarding events cancelled or degraded by weather serves two purposes. First, it ensures planners consider not just weather "showstoppers,"[46] but leads them to think about ways of optimizing knowledge of the environment (and its impact on Time-Space-Force) to deliver an advantage (surprise, speed, stealth, etc.,)...i.e., fold weather into the application of *Operational Art*. Secondly, and even more critically, it will force navy forecasters to take that important step toward delivering true actionable knowledge. A forecaster who fails to anticipate restrictive cloud development over a planned target must be held just as accountable as the squadron fuels officer that directs the wrong tank to be loaded. Such a shift in fleet attitude would

not only result in a higher quality product for the joint commander in the near-term, but would serve as a wake-up call for the Navy METOC community, and likely lead to wholesale changes in training, technology development, forecaster skill, and—ultimately—*value*.

Conclusion

"General Winter" and Halsey's typhoons serve as painful reminders of what can happen when bad plans meet bad weather. The meteorological sciences will likely never be perfect, and there are certainly times when operational commanders must accept some risk due to uncertainly in the forecast, especially in the maritime environment. Still, improvements in technology and forecasting expertise can serve to significantly strengthen a commander's tool kit, especially when applied to an adversary who avoids "force on force" confrontation.

While navy culture has acted to diminish the value of specialized weather support, it hasn't yet *killed* it. I have suggested actions the Maritime Component Commander can take *today* that will dramatically increase his ability to effectively operate in the littoral battlespace as well as challenge the Naval METOC community to aggressively reach toward that next level of environmental expertise. In future wars our opponents will likely seek to counter the U.S.' overwhelming force by using things like the terrain—and the environment—to their utmost advantage. Maybe the best we can do is a "draw" when it comes to knowing the terrain. But make no mistake: we can *own* the weather.

End Notes

[1] The CNMOC mission, according to the 2005 Strategic Plan, is "To provide an asymmetric war fighting advantage through the application of Oceanographic sciences." From Commander Naval Meteorology and Oceanography, Strategic Plan, 16 March 2005
[2] Saul David, "Sailing Against England," The London Daily Telegraph, 12 May 2003
[3] Both the French and Russian examples are taken from The Environmental Literacy Council, The Geography of War, 25 January 2005 (http://www.enviroliteracy.org/article.php/589.html)
[4] There is considerable debate as to whether Halsey "should have known" conditions were becoming dangerous. While there was no consensus on the precise location of the storm, 30-40 knot north winds on 17 December suggest a wind character that is far from typical in this location, and could arguably be viewed as reason enough to suspend operations and clear the area. Nimitz's comment taken from C. Raymond Calhoun, Typhoon: The Other Enemy, (Annapolis Maryland: Naval Institute Press, 1981), 216
[5] "Notes on Air Tactics Used by Japanese", Intelligence Bulletin, Vol. II, No. 4: December 1943
[6] Battle of the Bulge and Normandy accounts taken from: The Environmental Literacy Council, The Geography of War, January 25, 2005, (http://www.enviroliteracy.org/article.php/589.html)
[7] NOAA History, NOAA Legacy Timeline: 1900-1969, April 7, 2004 (http://www.history.noaa.gov/legacy/time1900_1.html)
[8] Joint Chiefs of Staff, Doctrine for Joint Operations, Joint Publication 3-0, September 10, 2001, xiii
[9] Chairman of the Joint Chiefs of Staff, Meteorological and Oceanographic Operations, Chairman of the Joint Chiefs of Staff Instruction 3810.01B, August 25, 2003
[10] This should in no way be viewed as a suggestion that the JFLCC and JFSOCC have any less of a requirement for weather-derived knowledge (and indeed it could be argued they have *more*). A JFACC/JFMCC emphasis simply offers the best opportunity for direct comparison.
[11] Most would suggest the "J" has been effectively replaced by "C" (combined), due to the virtual certainty of Combined (read: multi-lateral) warfare in the future. For my purposes, however, I will use the "J" as seen in joint definitions.
[12] Rebecca Grant, "Storms of War," AIR FORCE Magazine, (July 2004): 45
[13] Joint Chiefs of Staff, Command and Control for Joint Air Operations, Joint Publication 3-30, June 5, 2003, II-6, III-3, III-7.
[14] Previous two quotes taken from Rebecca Grant, "Storms of War," AIR FORCE Magazine, July 2004, 45
[15] United States Air Force, The Air War over Serbia: Aerospace Power in Operation Allied Force, Initial Report, April 2000
[16] Carl H. Builder, The Masks of War, (Baltimore Maryland: The Johns Hopkins University Press, 1989), 32
[17] Both of these (Fahlbusch and Moseley) quotes are taken from Rebecca Grant, "Storms of War," AIR FORCE Magazine, July 2004, 47
[18] These represent the main themes highlighted in the Executive Summary of: Air Force Weather, AFW Transformation: Strategic Plan and Vision FY 2008-203, August, 2004 (i-iv)
[19] From Forward to Air Force Weather, AFW Transformation: Strategic Plan and Vision FY 2008-203, August, 2004
[20] Joint Chiefs of Staff, Command and Control for Joint Maritime Operations, Joint Publication 3-32, Second Draft, March 16th, 2005, v
[21] Milan N. Vego, Operational Warfare, Naval War College Publication (NWC 1004), 2000, 131
[22] Milan N. Vego, Operational Warfare, Naval War College Publication (NWC 1004), 2000, 134
[23] Joint Chiefs of Staff, Command and Control for Joint Air Operations, Joint Publication 3-30, June 5, 2003, II-6, III-3, III-7.
[24] Joint Chiefs of Staff, Command and Control for Joint Maritime Operations, Joint Publication 3-32, Second Draft, March 16th, 2005, F-3
[25] From email interview with CDR Jim Pettigrew, former METOC officer, US Seventh Fleet, 5 May 2005. (pettigrewj@yoko.npmoc.navy.mil)
[26] Calhoun is referring to a rule-of-thumb in Bowditch's The American Practical Navigator, which states that a drop in barometric pressure of >.03 in/hour combined with increasing wind force suggests a vessel is

on or near the track of a storm (Calhoun, Typhoon: The Other Enemy, 17). His comment about the JOs applying this thumb rule is found on Calhoun, Typhoon: The Other Enemy, 39.

[27] Halsey in fact addressed a rather surreal message to All Third Fleet: "Do you have any information [regarding] present condition, or last known position of *Spence* (DD512), *Monaghan* (DD354), or *Waterman* (DE 740)?" C. Raymond Calhoun, Typhoon: The Other Enemy, Naval Institute Press, Annapolis Maryland, 1981, 100

[28] Raymond Calhoun, Typhoon: The Other Enemy, (Annapolis Maryland: Naval Institute Press, 1981), 173

[29] Email interview with CAPT (Sel) Jim Pettigrew, former METOC officer, US Seventh Fleet, 5 May 2005. (pettigrewj@yoko.npmoc.navy.mil)

[30] Pettigrew notes that aggressive afloat METOC teams can influence joint planning "up front," but that this is a personality driven process, i.e., there is no doctrine "telling you to do it." Based on email interview 5 May 2005.

[31] Assessment based on interviews with current and former naval METOC officers assigned to NWC (CDR Frank Baker, CDR (ret) Jeff Barker, LCDR Rick Fritsch)

[32] Interview with CAPT Sandy Neville (Naval Intelligence Officer), JMO Department, NWC, 25 April, 2005

[33] Interview with LtCol Derrill Goldizen (Air Weather Service Officer), JMO Department, NWC, 25 April, 2005

[34] Air Force Weather, AFW Transformation: Strategic Plan and Vision FY 2008-2032, August, 2004, 5

[35] As an example, CDR Matthews cites an effort to place weather-sensing "dropsondes" on tactical air platforms. "The idea was that on a given sortie the dropsonde could be deployed behind enemy lines to provide environmental information that would enhance analysis and forecast of the environment for future sorties over the same area. The aviation community balked at removing any number of chaff or infra-red flare decoys and replacing them with the dropsonde sighting a safety of flight/self-defense issue. The case could not be made that environmental data over the battlefield could provide enough combat capability improvement to counter the added risk to the aircrew that would lose some of their defensive capability." Interview, CDR Paul Matthews, 9 May, 2005. (Paul.Matthews@nwc.navy.mil)

[36] It is not my intention to give short shrift to the role of naval oceanography, and in particular acoustic propagation analysis. Vego (p. 130) gives a summary of the importance of understanding sound transmission from an operational art standpoint, and as I have noted, CNMOC is currently focusing on this type of support. In this paper however I am concentrating on the weather aspects of naval METOC support since it is directly comparable to the other services.

[37] Email interview with Dr. Cliff Mass, Atmospheric Sciences Department, University of Washington, 20 May 2005. (cliff @atmos.washington.edu)

[38] Based on time series of monthly mean anomaly correlations for 5-day forecasts of 500-hPa heights. From NCEP "Model Performance Statistics," Updated as of 1 May, 2005 (http://www.emc.ncep.noaa.gov/gmb/STATS/html/aczrnmn4.html)

[39] This must be skillfully done. A blind application of extended range models is not recommended. Trained, experienced forecast teams can use other tools, such as "ensembles" to make assessments as to the reliability of individual long-range solutions.

[40] S. Saha, S. Nadiga, C. Thiaw, J. Wang, W. Wang, Q. Zhang, H. M. van den Dool, H.-L. Pan, S. Moorthi, D. Behringer, D. Stokes,G. White, S. Lord, W. Ebisuzaki, P. Peng, P. Xie, "The NCEP Climate Forecast System", Submitted to J. Climate, Aug, 2004 (see abstract at http://nomad6.ncep.noaa.gov/).

[41] Raymond Calhoun, Typhoon: The Other Enemy, (Annapolis Maryland: Naval Institute Press, 1981), 165

[42] Joint Chiefs of Staff, Command and Control for Joint Maritime Operations, Joint Publication 3-32, Second Draft, March 16th, 2005, F-4

[43] Joint Chiefs of Staff, Command and Control for Joint Maritime Operations, Joint Publication 3-32, Second Draft, March 16th, 2005, F-3,4

[44] Neville interview 25 April, 2005

[45] These documents (MMAP, MTO) are not currently defined in joint doctrine, but were notionally used in the Naval Warfare Development Center's experiment *Millennium Challenge 2002* (MC02).

[46] "Go-No Go" criteria related to weather conditions are of course important to the final execution of a plan. My point here is more focused on the operational art of building in an advantage throughout the planning and execution range based on superior understanding of the environment.

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